Title	The milkfish industry in Taiwan.
Author(s)	Lee, Chaur Shyan.
Citation	Lee, C.S. (1984). The milkfish industry in Taiwan. In: J.V. Juario, R.P. Ferraris, & L.V. Benitez (Eds.) Advances in milkfish biology and culture: Proceedings of the Second International Milkfish Aquaculture Conference, 4-8 October 1983, Iloilo City, Philippines. (pp. 183-198). Metro Manila, Philippines: Published by Island Pub. House in association with the Aquaculture Department, Southeast Asian Fisheries Development Center and the International Development Research Centre.
Issue Date	1984
URL	http://hdl.handle.net/10862/161

THE MILKFISH INDUSTRY IN TAIWAN

Chaur Shyan Lee
Research Institute of Agricultural Economics
National Chung Hsing University
Taichung, Taiwan

This paper attempts to explain empirically the entire milkfish industry in Taiwan, covering (1) the gathering and marketing of milkfish fry — the procurement subsystem; (2) the production of milkfish fingerlings for the baitfish industry; (3) the production of market-size milkfish — the transformation subsystem; and (4) the marketing of market-size milkfish — the delivery subsystem. A constant elasticity of substitution production function is used to estimate the input-output relationship for baitfish and market-size production systems, with all inputs classified into labor and capital. An important finding is that the elasticity of substitution between labor and capital exceeds unity, indicating rather easy substitution between the two inputs in the milkfish industry in Taiwan. The area for aquaculture has expanded rapidly during the past two decades, but the milkfish production area has remained at about 15 000 ha and yields have increased slowly compared with those of other cultured species. The revenue per hectare is also lower for milkfish production than for other freshwater fish. The improvement of fishpond management and the adoption of new rearing technologies are essential to avoid such inefficiencies in production and to increase the income of producers.

INTRODUCTION

The fisheries sector, including aquaculture, has played a significant role in the agricultural development of Taiwan. The relative importance of this sector can be seen in the fact that its share of total agricultural production increased from 11% in 1950 to 22% in 1982, while the share of crop production declined from 64% to 49%.

Intensive land use is a tradition in Taiwan. Farmers grow crops and raise animals year-round wherever possible and have changed from crops to fish culture to maximize the profit from their farmland and to sustain their relatively high standard of living. The area devoted to fish culture increased from 38 148 ha in 1965 to 64 663 ha in 1982. Milkfish is the most important species cultured in Taiwan; in 1982 15 218 ha — about 23% of the total area — were used for milkfish.

Basic biological research on milkfish in Taiwan has been intensive, but there have been few economic studies of production. Moreover, there has been no economic analysis of the fry input sector, nor of the marketing of milkfish. Thus, a systematic economic analysis of production and marketing of milkfish is needed to assist production programs and to sustain the incomes of producers and other support groups within the sector.

This paper examines the entire milkfish system in Taiwan, including fry gathering and marketing, baitfish production, market-size rearing, and marketing, the last consisting of three subsystems, namely, procurement, transformation, and delivery. The paper provides an overview of the milkfish industry to: (1) examine the gathering and marketing of milkfish fry, (2) measure the production efficiency of the baitfish industry, (3) explain the input-output relationship of production of market-size milkfish, and (4) describe the marketing of market-size milkfish.

GATHERING AND MARKETING OF FRY

Fry Gathering

The main sources of fry are located on the southern and eastern coasts of the island. However, there are significant regional variations in procurement. During 1980-82 the eastern coast accounted for about 53% of the total fry catch. The total procurement of fry varies yearly due to meteorological and oceanographic changes that affect milkfish spawning and, consequently, the distribution of eggs and fry. Fry procurement is also influenced by the technique of fry gathering and by the degree of water pollution in the coastal areas.

There is an important relationship between technique of fry gathering and fry procurement (Chen 1952, Lin 1968). Fry gathering can be increased by gear improvement. There are different methods used in Taiwan to catch fry, ranging from simple hand-operated scoop nets and sweepers that can easily be handled by one person to motorized rafts and boats.

Fluctuations in fry supply occur from year to year. From 1965 to 1982, the catch varied from a low of 33.96 million (1967) to a high of 234.87 million (1970). Since 1970, fry procurement has decreased year by year, nearing 101.42 million in 1982 (Taiwan Fisheries Yearbook 1982).

The trend in fry procurement can be presented by regression equations for the periods 1965-82 and 1970-82. On the average, the trends over the two periods were:

$$Q = 144\ 872.08 - 3224.27\ t\ (1965\text{-}1982),\ r^2 = 0.1260$$

$$Q = 180\ 001.31 - 9327.37\ t\ (1970\text{-}1982),\ r^2 = 0.5425$$

where Q stands for the quantity of fry caught and t shows the number of years. The equations indicate that the number of fry caught decreased annually at an average of 3224 and 9327 thousand pieces during these periods.

Taiwanese fry procurement is characterized by extreme seasonality, reflected in marked peaks and slack periods. The index of seasonal variation reached 578.03% and the standard deviation of seasonal variation was 120.90.

Marketing and Distribution of Fry

Fry marketing and distribution are the core of the procurement subsystem and involve methods of transportation, marketing channels, marketing margins, regional distribution, and price variation.

Methods of transport. As a general rule, the transport route for fry is short and usually involves only three transactions: (1) from gatherers to middlemen, (2) from middlemen to dealers, and (3) from dealers to milkfish and baitfish rearing ponds.

The main methods used to transport fry from the gatherers to the middlemen are bicycle (75%), walking (16%), and motorcycle (9%), and the distance of the fry middlemen from the seashore averages 4.8 km. The most common type of transaction is for the middlemen to go to the seashore where the fry are stored temporarily by the gatherers (75%), but 14% of the middlemen go to the gatherers' houses, and 11% of the gatherers deliver their fry to the middlemen.

Short distances are also involved between the middlemen and the dealers, and the fry are transported by taxi (55%), motorcycle (27%), truck (9%), and train (9%) with a 98% survival rate. Transportation costs depend on the distance and transportation facility used, but the average transportation cost per 10 000 pieces is US$5.22.

The last phase involves moving the fry from the dealers to the baitfish rearing ponds and market-size milkfish rearing ponds. Traditionally, the fishpond operators go to the dealers to buy the fry, and they handle transport themselves. Fry are most commonly transported by motorcycle or truck, depending on the distance and the quantity purchased.

Marketing channels and marketing margins. The marketing channels for fry can be divided into two phases: (1) before the middlemen phase — where 100% of the fry pass from gatherers to middlemen and (2) after the middlemen. After the middlemen, the method of distribution varies: 3% are transported from middlemen to market-size rearing ponds, 92% go to dealers, and 5% move directly to baitfish rearing ponds. Finally, the dealers distribute their fry to market-size milkfish rearing ponds (58%), overwinter fry nursery ponds (23%), and baitfish rearing ponds (19%).

Because the marketing channels for fry are short, the marketing margins are also small. The prices per fry received by fry gatherers and dealers were US$0.06 and US$0.07, respectively, in 1979.

Distribution of fry. Tainan City is considered the fry trading center of Taiwan; 66% of the fry come from the eastern coast and 31% from the southern coast. The primary demand for fry comes from the Tainan area: 44% of the fry go to Tainan Hsien, 24% to Tainan City, 14% to Chai-I Hsien, and 11% to Kaohsiung Hsien.

Price analysis of fry. As the quantity of fry increases, the price decreases. This relationship between the price of fry and the supply can be represented by regression equations for the periods 1965-82 and 1970-82:

$$\log P_f = 8.5211 - 0.7108 \log Q_f \qquad (1965\text{-}82)$$
$$(t \text{ value} = -3.7060) \qquad r^2 = 0.4780$$

$$\log P_f = 8.0853 - 0.6758 \log Q_f \quad (1970\text{-}82)$$
$$(t \text{ value} = -4.4002) \quad r^2 = 0.6377$$

where P_f stands for the price of fry (in real terms) and Q_f shows the quantity caught. These equations indicate that the supply of fry is the main factor affecting their price.

To determine the long-term trend of fry prices, the least squares method was used to calculate the regression equations. The trends of fry prices are as follows:

$$P = 0.5644 + 0.0853\ t \quad (1965\text{-}82)$$
$$r^2 = 0.4820 \quad \text{(at current prices)}$$
$$P = 1.8246 - 0.0272\ t \quad (1965\text{-}82)$$
$$r^2 = 0.0457 \quad \text{(at constant prices)}$$

and

$$P = 0.2785 + 0.1693\ t \quad (1970\text{-}82)$$
$$r^2 = 0.9244 \quad \text{(at current prices)}$$
$$P = 0.9381 + 0.0604\ t \quad (1970\text{-}82)$$
$$r^2 = 0.4569 \quad \text{(at constant prices)}$$

where P stands for the price of fry and t is the number of years. The equations show that the price of fry increased annually in terms of current price and decreased annually in terms of constant price during 1965-82, but during the period 1970-82, the fry price increased annually in terms of both current and constant prices. The seasonal variation in price is high because fry gathering is characterized by extreme seasonality. The total range of seasonal variation in the price reached 200% and the standard deviation of the seasonal index was 52.02.

The price stability of fry can be computed by using the Michaely Index. On the average, the indices of instability of fry price at current prices measured by the Michaely Index during 1965-82 and 1970-82 were 65.78% and 24-86%, respectively, which indicate extreme instability. At constant prices, the indices of instability were 62.46% and 20.43%, respectively, for the same periods, which also indicate extreme instability.

PRODUCTION OF FINGERLINGS FOR BAITFISH

Due to the development of the deep-sea tuna long-line industry in recent years, the production of milkfish fingerlings for baitfish has become an important business. Many factors such as the demand for such fingerlings, the production environment of milkfish, and the relative profitability of market-size milkfish and baitfish affect the rearing of milkfish fingerlings.

The rearing of fingerlings depends on a favorable rearing environment and on the supply of fry caught from early April to September. There are three periods for fingerling rearing: (1) in early April for harvest before the end of May, (2) in early June for harvest within 60 days, and (3) in early August for harvest at the end of October (about 90 days are required because the weather is cooler and the fry grow more slowly).

Resource Use of Baitfish Farms

Baitfish rearing is a capital-intensive and labor-saving industry. Based on a field survey in 1980 the land input per farm averages 1.8 ha, the capital input per hectare is US$3186, and the labor input per hectare is 86 days. The capital input per hectare increases and the labor input per hectare decreases as farm size increases. For farms less than 1 ha, the average direct cost is US$3110 and the labor input is 96 days; the figures for farms larger than 1 ha are US$3237 and 80 days. Direct costs include fry, feeds, labor, fuel, and materials, while the indirect costs include rent, water, electricity, interest, maintenance, taxes, and depreciation of gear.

The relationship between farm size and stocking rate per hectare for baitfish rearing is very significant. For farms under 1 ha, the stocking rate of fingerlings per hectare is 37 091; for farms over 1 ha, the rate reaches 41 621. The survival rates are 96% for farms under 1 ha and 92% for those larger than 1 ha.

Baitfish rearing in Taiwan has significantly affected both the benefit-cost ratio and rate of farm income as well as the factor productivity and elasticity of substitution. Milkfish fingerling rearing increases overall agricultural output and family farm income. Table 1 shows the benefit-cost ratio and the rate of farm income of different size baitfish farms in Taiwan. From the point of view of farm income, the benefit-cost ratio is highly related to the size of the baitfish farm. Farms under 1 ha have lower farm income than larger farms. The rate of farm income increases with an increase in the size of the fingerling-rearing farm. The rate of farm income was higher for farms over 1 ha than for farms under 1 ha.

The factor productivity of baitfish farms has advanced remarkably due to the increase of production per hectare and to the price of baitfish compared with market-size milkfish. Factor productivities are usually considered as important indicators of the level of economic efficiency of production of small farms. One important implication is that milkfish fingerlings have made a remarkable contribution to the growth of land, capital, and labor productivities. Hence, policy makers should place more emphasis on how this type of farming enterprise can be more effectively promoted within the milkfish sector if the market price and resource allocation are available.

A CES (constant elasticity of substitution) production function was used to measure elasticity of substitution in this study. The CES production function is:

$$Q = \gamma \left(KC^{-\rho} + (1 - K)N^{-\rho}\right)^{-\upsilon/\rho}$$

Where Q, C, and N represent output, capital input, and labor input, respectively, γ is a scale parameter denoting the efficiency of a production technology, K is the distribution parameter indicating the degree to which technology is capital intensive, υ represents the degree of homogeneity of the function or the degree of return to

Table 1. The benefit-cost ratio and rate of farm income per hectare for baitfish farms.

Farm size (ha)	Farm receipts (US$) (1)	Production costs (US$) (2)	Farm income (US$) (3)=(1)-(2)	Farm income/ production costs (4)=(3)/(2)	Rate of farm income (5)=(3)/(1)×100
< 1	4521.39	3287.25	1234.14	0.38	27.30
> 1	4836.03	3392.86	1443.17	0.43	29.84
Average	4782.03	3351.22	1430.78	0.42	29.92

scale, and ρ is the substitution parameter equal to $(1 - \sigma) / \sigma$, where σ is the elasticity of substitution. Then we can estimate σ where $\sigma = 1/(1 + \rho)$. The results of estimation of the CES production function and estimated parameters for a baitfish farm are shown in Table 2.

Based on the farm survey data in 1979, baitfish rearing showed a significant relationship with factor productivity, which varied with farm size. Data from southern Taiwan indicate that the productivity of different size baitfish farms is closely related to the productivity of land, capital, and labor (Table 3). Factor productivity per hectare increases considerably with the adoption of intensive agricultural operations such as capital intensive inputs and new rearing technologies.

Based on the estimated parameters of the CES production function of baitfish farms, it is clear that the effect of technology ( ) on the production of baitfish farms is significant. With relative increases in capital inputs and relative decreases in labor inputs, capital is a significant substitute for labor, and labor-saving technology has been utilized in the baitfish farms.

The elasticity of substitution between capital and labor in baitfish farms was high. On the average, the value of elasticity of substitution was greater than 1 because capital input is growing more rapidly than labor input in this type of farming.

Marketing Channels and Marketing Costs of Baitfish

The marketing channels are very short for milkfish used as baitfish. Baitfish producers buy fry from fry dealers, and the farmers raise and sell some of the fingerlings to market-size milkfish producers (about 35% of the total) because of the decline in demand for milkfish as bait for deep-sea fishing in recent years. The fry, after being stocked in the nursery ponds for 60-90 days, become fingerlings that are suitable as baitfish for tuna long-liners.

In 1979, the marketing cost for 100 pieces of milkfish-bait was US$5.50. Of this total, the profit of the middlemen accounted for about 51%, salaries 12%, transportation 15%, oxygen 5%, losses 8%, and other expenses 9%.

PRODUCTION OF MARKET-SIZE MILKFISH: TRANSFORMATION SUBSYSTEM

Overview of Milkfish Production

Milkfish production is centered in the southern coastal areas of Taiwan and is entirely in the private sector, largely individual milkfish farmers whose ponds range from under 1 ha to 20 ha. A small number of companies are involved in milkfish production, and their farms are larger than 50 ha.

The total production area showed a slight decrease from 15 616 ha in 1965 to 15 218 ha in 1982. Total milkfish production was stable between 27 000 and 32 000 t/year from 1965 to 1982, although the annual fry catch varied from 34 million to 235 million during the same years. Annual milkfish production per hectare increased from 1765 kg in 1965 to 2087 kg in 1979 and declined to 1940 kg in 1982.

Milkfish production is influenced not only by the relative profitability of baitfish rearing but also by the relative yield per hectare of other freshwater fish. The area

Table 2. Results of estimation of CES production function and estimated parameters for baitfish farm.

	Farm size (ha)		
	>1	<1	Average
	2.8358	3.5711	2.7845
B2	0.1095 (6.0180)*	0.6961 (0.1358)*	0.2635 (0.3044)
B_3	0.6998 (0.3710)	0.2912 (5.7405)*	0.6223 (0.6932)
B_4	9.2204 (7.5015)*	3.6017 (0.1172)	1.4067 (0.2431)
F_2	54.2665	396.5886	295.7764
R	0.9585	0.9876	0.9715
n	11	25	36
γ	17.0442	35.5555	16.1914
K	0.1353	0.7051	0.2975
υ	0.8092	0.9873	0.8858
ρ	0.1948	0.3509	0.1520
σ	1.2419	1.5405	1.1793
R^2	0.9585	0.9876	0.9715
S	0.1293	3.5863	7.6406

Note: Numbers within parentheses are t-values; an asterisk denotes significance at the 95% confidence level. Number of farm households equals n.

devoted to milkfish production compared with the total aquaculture area decreased from 41% in 1965 to 23% in 1982, while the production of other species increased from 59% to 77% in the same period.

Resource Use of Milkfish Farms

For small farms with large capital, the relative importance of land in milkfish production has gradually decreased. Working capital is the major factor substituting for land in the expansion of milkfish production.

In 1979, land input for milkfish farms ranged from an average of 1.82 ha for farms below 3 ha, to 5.75 ha for farms between 3 and 10 ha, to 25.64 ha for farms above 10 ha. The capital inputs of milkfish production consisted of 91% in direct costs and 9% in indirect costs. The average total capital input per hectare was US$2571. Labor inputs per hectare decreased relative to farm size from 117 days for farms of below 3 ha to 84 days for farms between 3 and 10 ha to 71 days for farms above 10 ha.

Table 3. Productivity and factor-factor ratio of baitfish farms.

	Farm size (ha)		
	<1	>1	Average
Per labor capital input C/N (US$/man-day)	31.11	41.92	38.83
Per capital labor input N/C (man-day/US$)	0.0000227	0.0000184	0.0000198
Per capital land input D/C (ha/US$)	0.0000002	0.0000002	0.0000002
Per land capital input C/D(US$/ha)	3264.75	3365.08	3345.55
Per labor land input D/N (ha/man-day)	0.010378	0.012460	0.011605
Per land labor input N/D (man-day/ha)	96.36	80.26	86.17
Land productivity Q/D (US$/ha)	4521.38	4844.47	4782
Labor productivity Q/N (US$/ha)	46.92	60.25	55.50
Capital productivity Q/C (US$/NT$)	0.0383332	0.04	0.0397221

Economic Analysis of Milkfish Production

The benefit-cost ratio and rate of farm income for market-size milkfish farms are closely related to farm size (Table 4), with large farms practising more efficient farming, resulting in higher farm income per hectare. The benefit-cost ratio and rate of farm income increased as farm size grew, mainly because of smaller labor inputs per hectare and increased efficiency of capital and labor in the larger milkfish farms. In larger farms, farmers can take advantage of technological change in combination with reduced labor inputs.

In comparing Tables 1 and 4, which show the benefit-cost ratios and rates of farm income in baitfish and market-size milkfish farms, it is clear that production of milkfish fingerlings for the baitfish industry is more profitable and efficient.

The productivity of a factor also depends on the quantities of other resources used. Table 5 shows that factor productivities are closely related to farm size.

By comparing with Table 3 it can be seen that the factor productivities are much higher in baitfish farms than in farms that produce market-size milkfish. If the purpose of using the milkfish resource is to maintain adequate resource returns and farm income in the face of growing competition from other freshwater fish rearings, a change from milkfish production to baitfish rearing if the market price and produc-

Table 4. Benefit-cost ratio and rate of farm income of milkfish farms.

Farm size (ha)	Farm receipts (US$) (1)	Production costs (US$) (2)	Farm income (US$) (3)=(1)-(2)	Rate farm income production costs (4)=(3)/(2)	Rate of farm income (5)=(3)/(1)×100
< 3	2684.03	2539.75	144.28	0.0568	5.38
3 - 1 0	2774.61	2569.08	205.53	0.0800	7.41
> 10	2866.53	2574-30	292.22	0.1135	10.19
Average	2834.81	2570.72	263.20	0.1024	9.28

Table 5. Productivity and factor-factor ratio of milkfish farms.

	Farm size (ha)			
	<3	3 - 1 0	>10	Average
Per labor capital input C/N (US$/man-day)	21.64	30.72	36.25	33.83
Per capital labor input N/C (man-day/US$)	0.0000335	0.0000249	0.0000213	0.0000227
Per capital land input D/C (ha/US$)	0.000003	0.0000003	0.0000003	0.0000003
Per land capital input C/D (US$/ha)	2539.75	2569.08	2574.30	2570.72
Per labor land input D/N (ha/man-day)	0.00852	0.01196	0.01409	0.01316
Per land labor input N/D (man-day/ha)	117.41	83.62	71.00	75.98
Land productivity Q/D (US$/ha)	2684.03	2774-61	2866.53	2834.81
Labor productivity Q/N (US$/ha)	22.86	33.20	40.39	37.31
Capital productivity Q/C (US$/NT$)	0.0293555	0.029999	0.0309749	0.0306305

tion environment are suitable is necessary for increasing productivity and efficiency of production.

Capital inputs play a very important role in milkfish production; thus, analysis of the capital inputs and elasticity of substitution between capital and labor in milkfish farming is useful for examining resource use and technological change in milkfish production. The elasticities of substitution are shown in Table 6, which is based on the CES production function. The high elasticity of substitution between capital and

Table 6. Results of estimation of CES production function and estimated parameters for milkfish farms.

	Farm size (ha)			
	< 3	3-10	> 10	Average
B_1	2.6376	3.1691	2.5641	2.9078
B_2	0.5288 (1.2202)	0.6793 (1.1070)	0.7742 (1.0507)	0.7660 (1.1968)
B_3	0.4051 (0.2829)	0.1659 (0.0261)	0.2116 (1.0079)	0.0170 (1.0044)
B_4	0.0234 (0.1752)	0.0019 (-1.0042)	- 0.0070 (- 0.9065)	0.0033 (-0.9120)
F	143.7766	56.6120	64.6766	171.6590
R^2	0.9664	0.8457	0.9023	0.8788
n	19	45	31	95
g	13.9797	23.7871	12.9883	18.3165
K	0.4337	0.8037	0.1358	0.6783
υ	0.9339	0.8452	0.8958	0.7830
ρ	0.2037	0.0286	0.1340	0.3998
	1.2556	0.9722	0.8818	0.7144
R^2	0.9664	0.8457	0.9023	0.8788
S	0.08030	0.0586	0.0643	0.0573

Note: Numbers within parentheses are t-values; number of farm households equals n.

labor in milkfish farming is primarily for farms under 3 ha, for which the value of elasticity of substitution (σ) is greater than one. The values of elasticity of substitution are less than 1 for the other two farm sizes.

MARKETING OF MARKET-SIZE MILKFISH: DELIVERY SUBSYSTEM

Marketing Channels and Marketing Margins

Three major marketing channels provide the link between producers and consumers:

- Producers — wholesalers — city fish markets — dealer-retailers — retailers — consumers
- Producers — cooperatives — city fish markets — dealer-retailers — retailers — consumers
- Producers — dealers — dealer-retailers — retailers — consumers

Milkfish farmers sell 71% of their products to wholesalers, 15% to cooperatives, and 14% to dealers.

The farm-retail marketing margins show the share of the consumer's money going to each intermediary. Producers received 74% of the retail price, with the remaining 26% being absorbed in the marketing process. The wholesalers and retailers received 79% and 89% of the city retail prices, respectively, in 1979.

Table 7 compares the wholesale farm prices and retail city prices, used to calculate the producer's share of the retail price during the period 1970-82. The producer's share generally decreased annually; on the contrary, the marketing group's share rose from 19% in 1970 to 31% in 1982, and the difference between the wholesale price of production and the retail price rose sixfold over the same time span.

Marketing Costs

Table 8 shows the marketing costs of milkfish in Taiwan. The total marketing cost per 100 kg was US$73.64, and the proportion of marketing cost to retail price was

Table 7. Farm price and retail price (US$/kg) of milkfish.

	Wholesale price of production (1)	Retail price in cities (2)	Difference in prices (3)=(2)-(1)	Producer's share (1)/(2) X 100
1970	0.63	0.78	0.15	2.25
1971	0.71	0.87	0.16	2.26
1972	0.84	0.94	0.10	2.53
1973	0.09	1.04	0.15	2.39
1974	1.35	1.45	0.10	2.58
1975	1.05	1.76	0.71	1.67
1976	1.21	1.91	0.70	1.75
1977	1.37	2.30	0.93	1.65
1978	1.55	2.61	1.07	1.64
1979	2.14	2.91	0.77	2.05
1980	2.245	3.16	0.91	1.97
1981	2.21	3.07	0.86	2.00
1982	1.97	2.84	0.88	1.92

Source: Taiwan Fisheries Yearbook.

Table 8. Marketing costs per 100 kg of milkfish by expenses.

	Marketing costs (US$)	Percentage of marketing costs
Market management	7.20	9.78
Taxes	5.33	7.24
Fisherman insurance	2.97	4.04
Freezing	3.03	4.10
Packaging	3.83	5.20
Transportation	5.72	7.78
Miscellaneous	9.94	13.50
Profit	35.61	48.36
Total	73.64	100.00

Source: Based on Lin and Chen (1980).

26%. Among the cost items, profits, market management and taxes combined, and freezing, packaging, and transportation combined were 48%, 17%, and 17% of total cost, respectively. Profits therefore accounted for the highest percentage of the costs incurred in marketing.

The marketing costs of milkfish in Taiwan can also be illustrated by the marketing costs of the different marketing agencies: the dealers, wholesalers, and cooperatives (Table 9). Dealers are considered as the lowest cost incurred in marketing. Because the dealers transport fish directly to dealer-retailers or retailers, there are no taxes, market management, and fisherman insurance fees during the marketing process.

Price Analysis of Milkfish

It is possible to explain the price variation of milkfish by long-run trend, seasonal variation, and price instability. The least squares method can be used to compute the regression equation for the period 1970-82. Trends in milkfish prices were:

At current prices

Wholesale farm price: $P_1 = 15.5050 + 5.0023\ t \qquad r^2 = 0.8820$

Retail city price: $P_2 = 43.3238 + 0.7196\ t \qquad r^2 = 0.4638$

At constant prices

Wholesale farm price: $P_1 = 14.7535 + 8.0605\ t \qquad r^2 = 0.9436$

Retail city price: $P_2 = 54.3923 + 1.6363\ t \qquad r^2 = 0.3257$

where P is the price of milkfish and t is the number of years. From these equations, the prices of milkfish, whether wholesale farm price or retail price, increased annually at

Table 9. Marketing costs per 100 kg of milkfish by different agencies.

	Dealer		Wholesaler		Cooperative	
	US$	%	US$	%	US$	%
Salary	2.11	12.65	2.22	8.82	1.86	9.27
Transportation	3.47	20.80	3.44	13.67	4.81	23.93
Freezing	2.08	12.48	2.08	8.27	2.89	14.38
Packaging	1.06	6.32	1.06	4.19	1.58	7.88
Profit	7.22	43.26	6.06	24.04	—	—
Taxes	—	—	1.94	7.72	.92	4.56
Market management	—	—	4.86	19.29	4.64	23.10
Fisherman insurance	—	—	2.53	10.03	2.42	12.03
Other expenses	.75	4.49	1.00	3.97	.97	4.85
Interest	.56	3.33	.53	2.10	.19	0.97
Equipment depreciation	—	—	—	—	.08	0.42
Water	—	—	—	—	.03	0.14
Electricity	—	—		—	.17	0.83
Fishery development funds	—	—	.31	1.21	.28	1.38
Mail and telegrams	.19	1.16	.17	0.66	.22	1.11
Total	16.69	100.00	25.19	100.00	20.08	100.00

both current and constant prices. The total ranges of the indices of seasonal variation of milkfish price were 89% and 115% of the wholesale farm price and retail city price, respectively. This shows that seasonal variation is higher in the retail city price than in the wholesale farm price.

To measure the price instability of milkfish, the Michaely Index was adopted to compute price data from the wholesale farm price and retail city price at both current and constant prices. At current prices, the wholesale farm and retail city prices showed substantial instability (17.95 and 13.70, respectively), while they showed substantial and slight instability (14.04 and 8.27, respectively) at constant prices.

Finally, comparisons between the price of other fish/shellfish and that of milkfish are required because milkfish is considered as a substitute for other fish. The trend in the freshwater fish/shellfish-milkfish price ratio from 1965 to 1982 decreased annually, except for oysters, the price of which increased annually faster than that of milkfish (Table 10).

The price ratio of milkfish to other freshwater fish increased annually during the 18 years under study because milkfish is considered a good fish in Taiwan. Nevertheless, the relative importance of milkfish in terms of production area relative to the total aquaculture area decreased from 41% in 1965 to 23% in 1982. This was because freshwater fish farms adopted new fishpond management and rearing technology, and the yield in these farms was higher than in milkfish production (Table 11).

CONCLUSION

In Taiwan, the demand for aquatic products increases proportionately with economic growth and per capita income increase. As a result, the aquaculture area has expanded rapidly. However, the milkfish production area has remained at about 15 000 ha and yields have increased slowly compared with other freshwater fish species. The revenue per hectare is also lower for milkfish production than for other freshwater fish. Under such conditions, growth in milkfish production has slowed. Improvement of fishpond management and the use of new rearing technologies are essential to avoid such inefficiencies in production and to increase the income of producers.

The main problems of the procurement subsystem are the supply and price of fry. To increase and maintain fry sources and stabilize prices, the control of water pollution in coastal areas, the improvement of fry gathering techniques, and the development of artificial spawning of milkfish fry must be emphasized. A good resource system should provide flexibility for the adjustment of farm management in response to changes in economic and technological conditions. For economies of scale and production efficiency, farmers should be encouraged to participate in group farming and contract farming to broaden their base of operations and to increase yields by adopting new rearing technologies such as deep water systems. This will allow them to meet the needs of dynamic economic and technological situations.

In 1979, the milkfish shipped to city markets through cooperative marketing by the Fisherman's Association accounted for only 15% of total milkfish production. Farmers should be encouraged to participate in cooperative marketing so that marketing costs can be decreased and producers' income can be increased.

Table 10. Average price ratios between other fish/shellfish culture and milkfish.

Year	Milkfish	Tilapia / Milkfish	Common carp / Milkfish	Grass carp / Milkfish	Silver carp / Milkfish	Eel / Milkfish	Oyster / Milkfish
1965	16.77	45.29	69.96	109.84	82.46	398.79	33.60
1966	17.29	45.51	20.63	108.67	82.13	379.95	35.99
1967	18.07	39.44	75.30	102.74	72.06	305.83	35.30
1968	20.12	38.40	71.16	95.15	65.62	382.90	43.49
1969	20.87	40.96	69.63	89.39	63.04	358.28	49.50
1970	21.29	38.94	70.42	91.27	58.72	372.19	91.94
1971	20.66	45.59	79.08	95.19	67.29	588.05	95.96
1972	23.13	40.25	65.23	88.78	54.39	745.41	95.75
1973	28.09	42.07	60.65	82.65	49.43	562.95	130.41
1974	36.93	40.58	51.35	71.99	45.45	471.52	113.36
1975	38.02	34.05	53.52	79.37	53.20	611.78	149.22
1976	42.24	37.41	57.32	77.06	40.00	423.46	138.43
1977	65.86	32.49	40.88	51.07	35.57	317.07	83.89
1978	59.40	37.76	49.90	57.54	42.12	499.03	127.68
1979	64.52	41.75	48.22	55.45	37.24	363.53	134.23
1980	90.34	33.59	43.33	45.63	32.82	219.60	109.68
1981	94.57	28.63	42.28	53.30	35.23	200.65	73.75
1982	67.80	43.50	62.46	81.05	52.96	359.82	162.47

Source: Calculated from Fisheries Yearbook, Taiwan Area.

Table 11. Yield ratios between other fish/shellfish culture and milkfish.

Year	Milkfish (kg)	Tilapia / Milkfish	Common carp / Milkfish	Grass carp / Milkfish	Silver carp / Milkfish	Eel / Milkfish	Oyster / Milkfish
1965	1 765	180.06	77.76	75.64	18.97	173.87	60.18
1966	1 863	169.19	58.87	72.46	19.88	204.21	64.74
1967	1 468	233.04	77.91	100.71	24.79	278.06	86.66
1968	1 216	303.59	95.75	137.32	35.40	458.96	110.90
1969	1 166	314.23	103.61	314.35	33.37	834.74	107.75
1970	1 703	305.96	49.82	52.77	34.86	420.50	79.20
1971	1 918	233.39	40.22	47.19	35.21	304.95	68.29
1972	1 590	195.47	71.69	66.43	40.56	385.52	89.04
1973	2 020	140.40	61.33	99.51	41.08	554.69	74.10
1974	1 847	164.09	80.06	109.47	44.95	570.20	81.04
1975	1 982	170.13	87.82	97.59	41.99	486.79	71.40
1976	1 621	237.08	93.89	138.98	63.72	702.31	86.40
1977	1 632	224.29	96.76	136.49	67.50	784.63	93.38
1978	1 935	172.79	81.04	146.40	80.16	512.10	87.38
1979	2 087	320.56	141.27	249.87	151.09	963.79	146.04
1980	1 249	299.92	175.31	203.39	145.42	1 114.54	133.55
1981	1 603	328.99	169.67	207.75	143.45	806.68	97.05
1982	1 940	251.15	137.87	154.15	103.50	709.67	87.62

Source: Calculated from Fisheries Yearbook, Taiwan Area.

LITERATURE CITED

Chen, T. P. 1952. Milkfish culture in Taiwan. JCRR, Fisheries Series 1.

Lee.C. S. 1981. Production and marketing of milkfish in Taiwan. Research Institute of Agri. Econ., National Chung Hsing University.

Lee, C. S. 1982. Economics of Taiwan milkfish system. Pages 45-57 *in* Aquaculture Economics Research in Asia, IDRC-193e, Ottawa, Canada.

Lin, H. T., and C. T. Chen. 1980. Fisheries marketing in Taiwan (in Chinese). Pages 143-169 in Chinese Economic Association Annual Conferences Proceedings, December.

Lin, S. Y. 1968. Milkfish farming in Taiwan. Fish Culture Report No. 3, Taiwan Fisheries Research Institute.

Taiwan Agricultural Yearbook. Department of Agriculture and Forestry, Provincial Government of Taiwan.

Taiwan Fisheries Yearbook. 1982. Department of Agriculture and Forestry, Provincial Government of Taiwan.